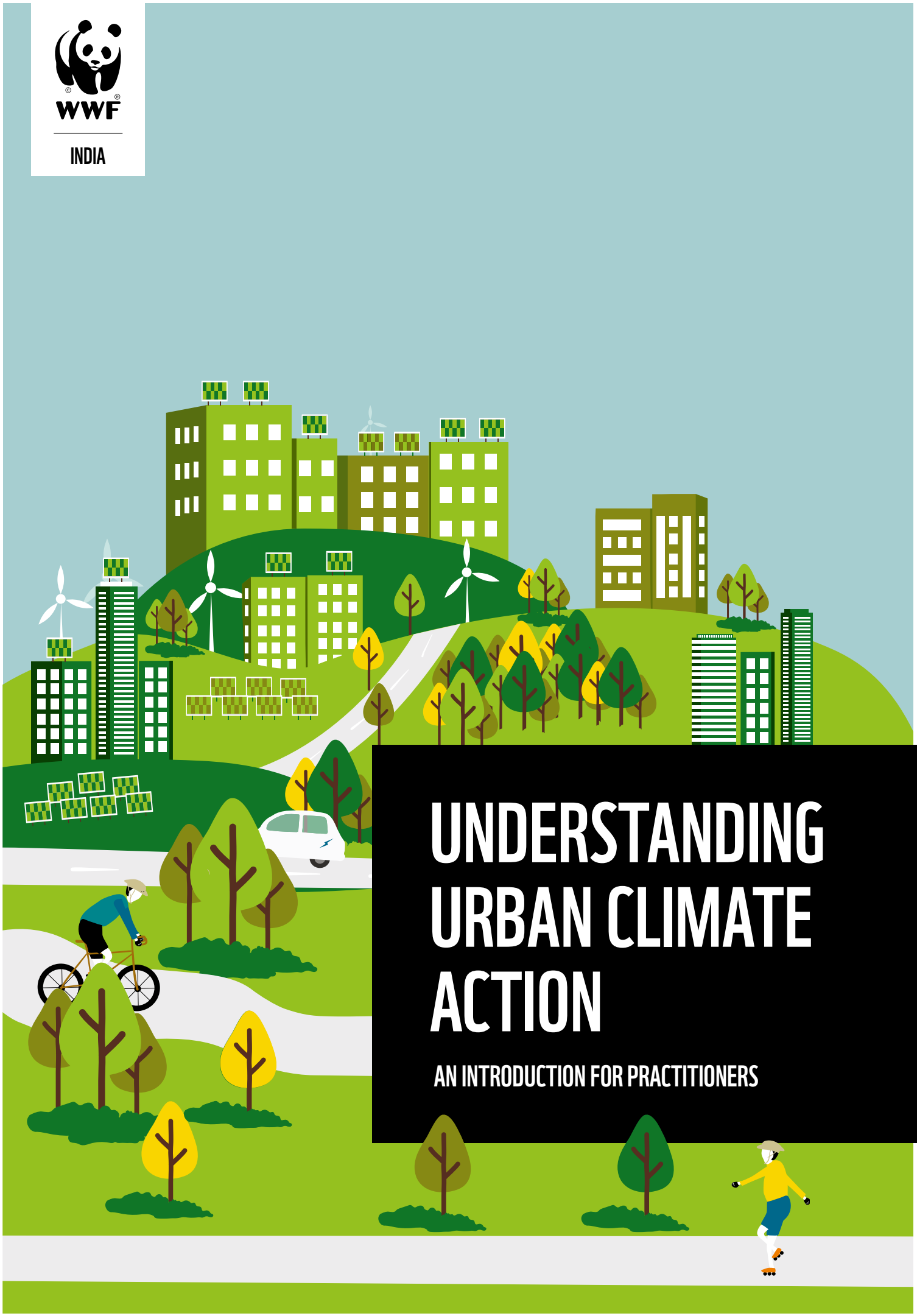
WWF

INDIA



UNDERSTANDING URBAN CLIMATE ACTION

AN INTRODUCTION FOR PRACTITIONERS

CONTENTS

For further details , please visit our website at wwfindia.org

Team:

Climate Change and Energy Programme, WWF-India

Suchismita Mukhopadhyay: smukhopadhyay@wwfindia.net

Sakshi Gaur: sgaur@wwfindia.net

Saurav Chowdhury

CLIMATE RISK: 1.5°C VS 2°C Global

ARCTIC SEA ICE

1.5°C Ice free summers in Arctic at least once every 100 years

2°C Ice free summers in Arctic at least once every 10 years

SEA LEVEL RISE

10cm more at **2°C** than at **1.5°C** in 2100. This difference will expose upto 10 million more people to risks

CORAL BLEACHING

1.5°C 70% of worlds coral reefs are lost by 2050

2°C Virtually all coral reef are lost by 2050

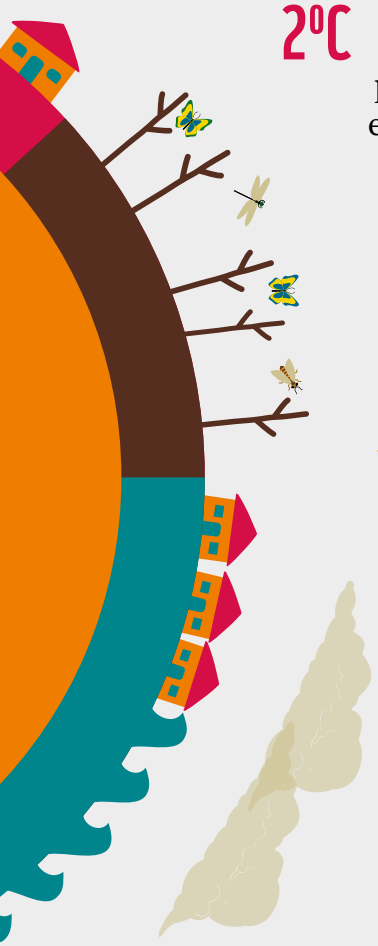
Source: WWF / Based on the IPCC Special Report on Global Warming of 1.5 °C and Special Report on the Ocean and Cryosphere in a Changing Climate

Warming

PEOPLE

1.5°C 9% of the world's population (700 million people) will be exposed to extreme heat wave at least once in 20 years

2°C 28% of the world's population (2 billion people) will be exposed to extreme heat wave at least once in 20 years



SPECIES

1.5°C 6% of insects, 8% of plants and 4% of vertebrates will be affected

2°C 18% of insects, 16% of plants and 8% of vertebrates will be affected

EXTREME WEATHER

1.5°C 100% increase in flood risk

2°C 170% increase in flood risk

BRIEF SUMMARY

The scale of recent changes across the climate system as a whole and the present state of many aspects of the climate system are unprecedented over many centuries to many thousands of years. It is unequivocal that human influence has warmed the atmosphere, ocean, and land.[1] By 2020, the concentration of carbon dioxide, one of the key greenhouse gases, had risen to 48 percent above its pre-industrial level. As a result of this, global warming is increasing at a rate of 0.2°C per decade. The period from 2011 to 2020 has been the warmest decade on record, with global temperatures soaring at 1.1°C above pre-industrial levels in 2019. A 2°C temperature increase compared to pre-industrial times is further going to impact the natural ecosystems, human health, and well-being, resulting in a higher risk of extreme weather events.

This compendium aims to build a basic understanding of the ongoing climate crisis, and guide the readers through various aspects of climate change at a global and national level. In particular, climate change and its impacts in urban areas are addressed in greater detail. The document highlights the co-benefits of climate action in cities. It provides specific case studies across various thematic areas, allowing the urban practitioners to better understand climate change mitigation and adaptation in cities.

The compendium provides a broad perspective on climate change, and its causes, impacts, and solutions at the local level and will be useful for awareness generation and capacity building among urban stakeholders.

1 INTRODUCTION TO CLIMATE CHANGE

Climate change is a long-term change in the average weather patterns that have come to define Earth's local, regional and global climates. Changes observed in Earth's climate since the early 20th century are primarily driven by human activities. These have increased heat-trapping greenhouse gas (GHG) levels in the atmosphere leading to a rise in Earth's average surface temperature. The long-term heating of Earth's climate system observed since the pre-industrial period (between 1850 and 1900) due to human activities is commonly referred to as global warming. Natural processes also contribute to climate change, including internal variability (e.g., cyclical ocean patterns like El Niño, La Niña, and the Pacific Decadal Oscillation) and external forcings (e.g., volcanic activity, changes in the sun's energy output, variations in Earth's orbit).[2] The United Nations Framework Convention on Climate Change (UNFCCC), in its Article 1, defines climate change as 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods'. The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition and climate variability attributable to natural causes.[3]

Increased concentrations of GHG such as carbon dioxide and methane in the atmosphere, mainly from anthropogenic or human activities, are primary causes of global warming and climate change. The anthropogenic sources of increasing GHG emissions include burning fossil fuels to meet energy needs in industries, transport, and buildings, along with agriculture, waste, deforestation, and forest degradation.

Global surface temperature was 1.09°C higher in 2011-2020 than 1850-1900 and will continue to increase until at least the mid-century under all the considered emissions scenarios. Human-induced warming reached approximately 1.07°C (likely between 0.8°C to 1.3°C) from 1850–1900 to 2010–2019, with the last four decades being successively warmer than any decade that preceded it since 1850.[4] This has resulted in the melting of polar ice and glaciers.

Further, warming greater than the global average has already been experienced in many regions and seasons, with higher average warming over land than the ocean.[5] According to the Scripps Institution of Oceanography and the National Oceanic and Atmospheric Administration (NOAA), the average global surface temperature in July 2021 was the highest for the month of July since 1880. Though warming has not been uniform across the planet, the upward trend in the globally averaged temperature shows that more areas are warming than cooling.[6] According to NOAA's 2020 Annual Climate Report, the combined land and ocean temperature has increased at an average rate of 0.13 degrees Fahrenheit (0.08 degrees Celsius) per decade since 1880; however, the average rate of increase since 1981 (0.18°C / 0.32°F) has been more than twice that rate. The ten warmest years on record have all occurred since 2005, and 7 of the 10 have occurred just since 2014.[7]

Climate change impacts are a result of multiple factors such as rising temperatures, increase in atmospheric CO2, shifting rainfall patterns, rising sea levels, ocean acidification, and extreme events such as floods, droughts, and heatwaves. Climate change has impacted the terrestrial biological systems, affecting flora and fauna in major biodiversity hotspots across the globe. Ocean acidification has adverse effects on marine life. Similarly, food systems have also been impacted due to temperature anomalies and increased frequency and severity of extreme weather events, which has led to lesser production of crops and other food items further worsening the issue of food security. Higher temperature also increases the production of ground-level ozone, which is a key contributor to smog. Since many GHGs are also long and short-lived pollutants, the air quality has also deteriorated, leading to severe health impacts on humans.[8]

According to the Climate Risk Index 2021, altogether, between 2000 and 2019, over 4,75,000 people lost their lives as a direct result of more than 11,000 extreme weather events globally, with losses amounting to around US$ 2.56 trillion (in purchasing power parities). Climate impacts, such as increasingly intense and frequent extreme weather events, disproportionately affect people in developing countries, threatening lives and livelihoods, human security, and sustainable development.

Health impacts of climate change

Climate change is leading to increased exposures to heat, poor air quality, extreme weather events, declining water quality, and decreased food security, resulting in health impacts. Climate change is also altering vector-borne disease transmission by enhancing the transmission season and expanding the geographical distribution of diseases (like dengue, malaria). Further, heat waves, cold spells, and other extreme events will bring new and emerging health issues.

Both drought and floods are risk factors for water-borne diseases (cholera and various diarrhoeal diseases). Floods contaminate freshwater supplies and increase the risk of water-borne diseases. The Lancet Countdown Report 2019 on Health and Climate Change stated that climate change in India may further append malnutrition levels and exacerbate infections caused due to cholera.[9] Incidences of vector-borne diseases such as malaria, dengue, and chikungunya fever are likely to increase due to climate change. Heat stress can make working conditions unfavourable and increase the risk of cardiovascular, respiratory, renal diseases, and heat-related illnesses. With 1.5°C warming, 350 million more people could be exposed to deadly heat stress by 2050.[10] Climate change is inextricably linked to air pollution. Climate change increases ground-level ozone and/or Particulate Matter (PM) that result in air pollution and affect human health. Air pollution and increasing aeroallergen levels are also high during extreme heat, triggering asthma and other respiratory diseases. Ground-level ozone (a key component of smog) is associated with many health problems, including diminished lung function, increased hospital admissions, emergency department visits for asthma, and increase in premature deaths.[11] The COVID 19 pandemic management has led cities to develop tools and approaches that can also be used to manage climate and disaster risk in the urban areas. The pandemic has paved the way for a data-driven risk management process that can be utilized for decision-making in times of natural disasters. Also, the pandemic saw an integration of various state and non-state actors like urban local bodies (ULBs), civil society organizations, and the private sector. Successful climate action, both in terms of mitigation and adaptation, requires complete coordination between multiple stakeholders at the local level. The lessons learned from the pandemic in setting up a holistic framework for providing relief to vulnerable communities and neighbourhoods under lockdown can be quite valuable during natural disasters like floods.[12]

Multiple studies have suggested that climate change would increase the chances of such widespread pandemics in the future. This has been further worsened due to the accelerated biodiversity loss, which presents the dangers of zoonotic viruses jumping into human civilization. Hence, addressing climate change and biodiversity demands immediate attention and holds one of the keys to prevent future pandemics.[13]

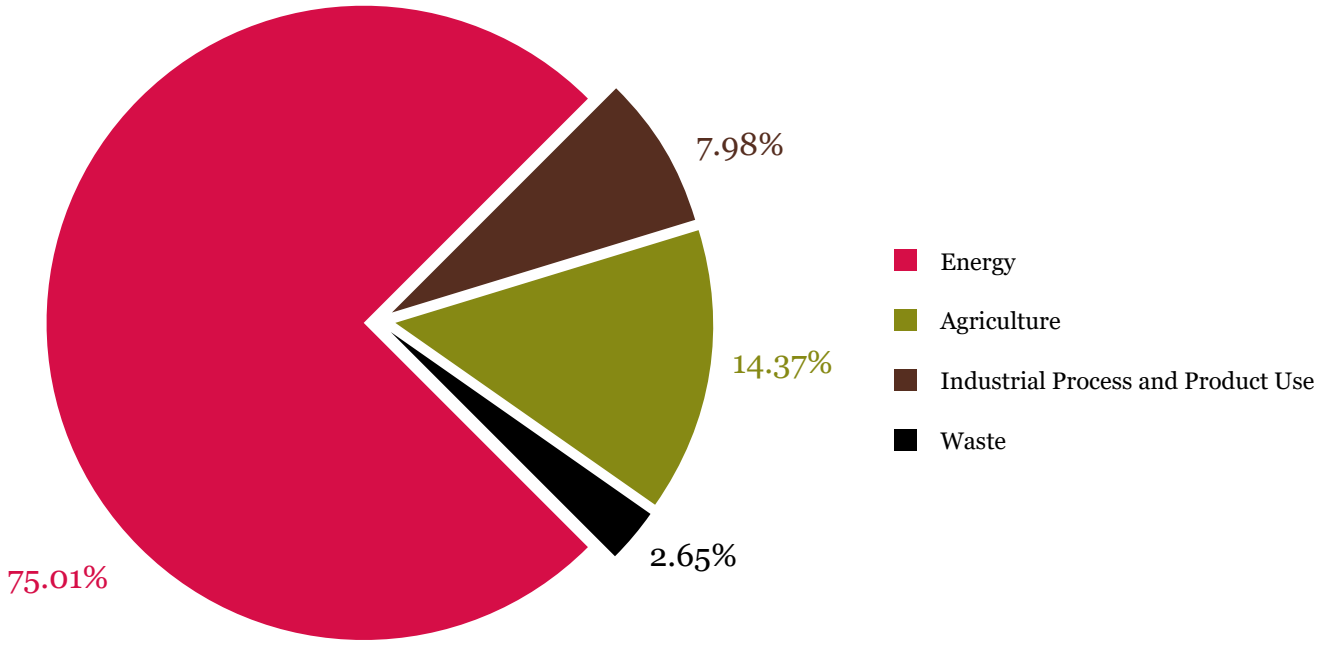
1.1 India scenario

Due to its unique geo-climatic and socio-economic conditions, India is vulnerable (in varying degrees) to floods, droughts, cyclones, urban flooding, landslides, avalanches, and forest fires. The country witnesses 2,925 fatalities every year on average due to extreme weather events with huge economic losses.[14] 12 percent of the land area in India is prone to flood and river erosion; of the around 7,500 km coastline, 5,700 km is prone to cyclones; 68 percent of the cultivable land is vulnerable to drought; while hilly areas are at risk from landslides and avalanches, and 15 percent of the landmass is prone to landslides. Disaster risks in India are further compounded by changing demographics and socio-economic conditions, unplanned urbanization, development within high-risk zones, environmental degradation, climate change, geological hazards, epidemics, and pandemics.[15] India was the seventh most climate-affected country in 2019[16], with more than 478 extreme weather events witnessed between 1970-2019, most of which occurred after 2005.[17] About 75 percent of the districts in India are now prone to extreme weather events such as cyclones, floods, droughts, heat, and cold waves. Between June to end of September 2019, 110 percent of the average rainfall occurred, the most since 1994. Floods caused by the heavy rains were responsible for 1,800 deaths across 14 states and led to the displacement of 1.8 million people. Overall, 11.8 million people were affected by the intense monsoon season, with the economic damage estimated to be USD10 billion.[18] 2019 was one of the most active Northern Indian Ocean cyclone seasons on record, with a total of eight tropical cyclones, six of which intensified to become "very severe".[19] During 2020, 5 cyclones formed over the North Indian Ocean. The year 2020 was the eighth warmest year on record since nationwide records commenced in 1901. The country also experienced other high-impact weather events like heavy rainfall, floods, landslide, thunderstorm, lightning, cold waves, etc.[20]

India's GHG emissions have nearly tripled between1990 and 2017, mainly due to a sustained increase in energy-related emissions. It is predicted that India is likely to witness 0.5°C warming by the end of 2030, and 2-4°C by 2100, with the maximum increase over northern India. This increased warming is also likely to increase ozone pollution, and air pollution levels across Indian cities.[21] The impact of an increase in temperature across India has also been visible in the Himalayan regions. Most of India's glaciers are retreating at accelerated rates. This retreat of glaciers will enormously impact the key river basins by increasing the river runoff.

Meanwhile, the Indian coastline has witnessed changing sea levels at different rates across its length. While rising sea levels alone may not impact much, however, it can exacerbate the coastal inundation along the low-lying areas during extreme events such as tsunami, storm surge, coastal flooding, and coastal erosion. As around 14 percent of India's population resides on its coast, the urban population in the coastal cities, including Mumbai and Chennai, are highly vulnerable to sea-level rise, coastal hazards, and the increasing risk of infrastructure damage.[22]

It is also expected that India would witness unusual and unprecedented heatwaves more frequently over a large area. Since 1950, a decline in monsoon rainfall has been observed with an increased frequency of extreme rainfall events. Many parts have also become drier since the 1970s with increased drought-like events. Since a larger share of India's agriculture is rain-fed, this would increase the dependence on groundwater. While overall rice yields have



GHG emissions (GgCO2e) by sector in India, 2016
(Source: MoEFCC. (2021). India: Third Biennial Update Report (BUR) to the UNFCCC)

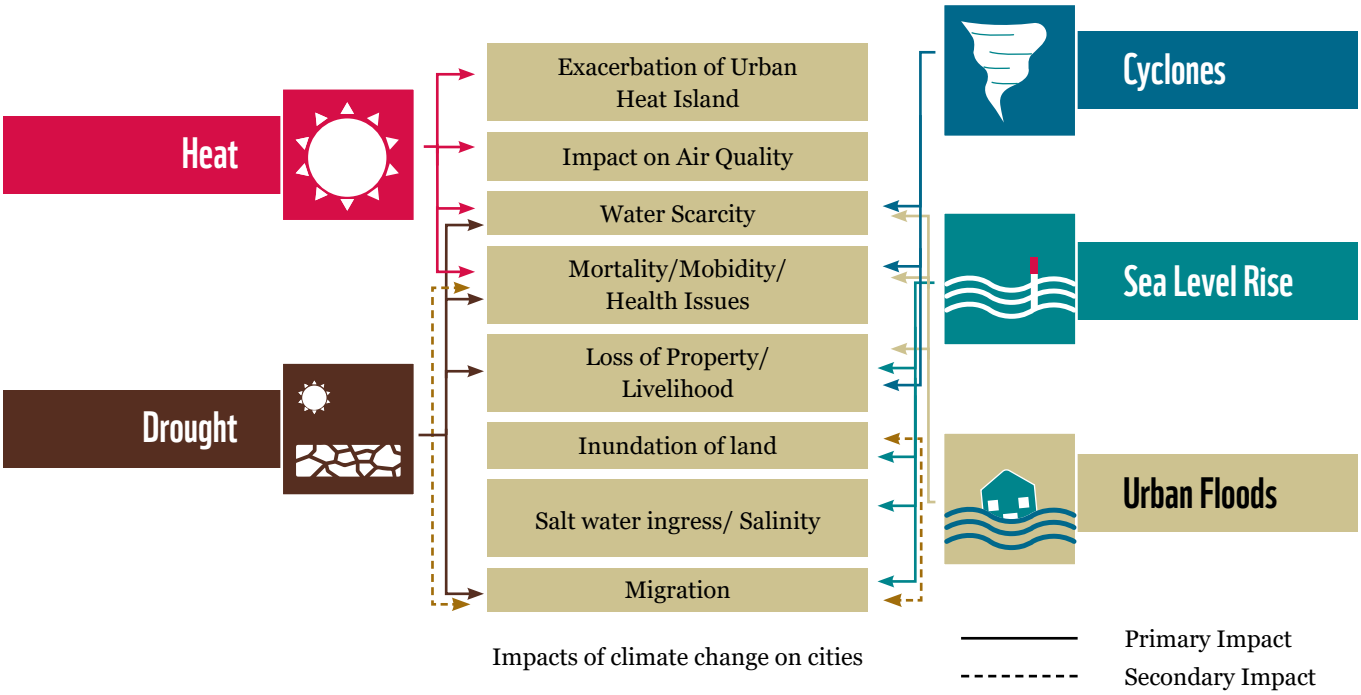
increased, rising temperatures with lower rainfall at the end of the growing season have caused a significant loss in India's rice production. Observations show that extremely high temperatures in northern India have had a substantial negative effect on wheat yields. Rising temperatures will only aggravate the situation further. Climate change is also expected to have significant health impacts in India, like increasing malnutrition and other related health disorders. Malaria and other vector-borne diseases and diarrheal infections- the major cause of child mortality, are likely to spread into areas where colder temperatures had limited transmission previously. Heatwaves will result in a substantial rise in mortality and death, with increase in injuries from extreme weather events.[23]

2 CITIES AND CLIMATE CHANGE

Over half of the world's population lives in cities, which is likely to increase to over two-thirds by 2030. By 2050, it is estimated that 68 percent of the global population will live in urban areas, resulting in higher use of resources in cities.[24] Cities are seen as significant contributors to climate change, as various urban activities are sources of GHG emissions. Estimates suggest that cities are responsible for 75 percent of global carbon emissions, with transport and buildings being the most significant contributors. In addition, cities use a large proportion of the world's energy supply.

Cities are also among the areas most affected by climate change. 70 percent of cities globally are already dealing with the effects of climate change. Rising global temperatures cause sea level rise and increase the occurrence of extreme weather events such as floods, droughts, and storms. These often have adverse impacts on basic services in cities such as infrastructure, housing, human livelihoods, and health.

India has witnessed rapid urbanisation, with a current population of more than 30 percent living in urban areas, and expected to be 40 percent by 2030. Estimates indicate a tripling of India's built environment (human-made spaces, such as buildings) to accommodate 200 million more urban dwellers by 2030.[25] As Indian cities cater to the growing population, they would also be faced with challenges related to providing basic necessities such as housing and transport. This would further lead to increased demand for energy and water, higher emissions and waste generation, deteriorating air quality, and associated health impacts. Nearly 44 percent of India's rapidly growing carbon emissions have urban origins, emanating from transport, industry, buildings, and waste, contributing towards climate change. Within urban areas, the megacities, metro cities, and class I cities generate 59 percent of the GHG emissions in the country.[26] This makes our cities vulnerable and imposes huge risks of increased water stress, heat island effect, and increased frequency and severity of extreme weather events such as urban floods and droughts. Further, air quality deterioration poses severe challenges for city administrators. A total of 102 cities in India, of which 43 are Smart Cities, are already facing poor air quality.[27]

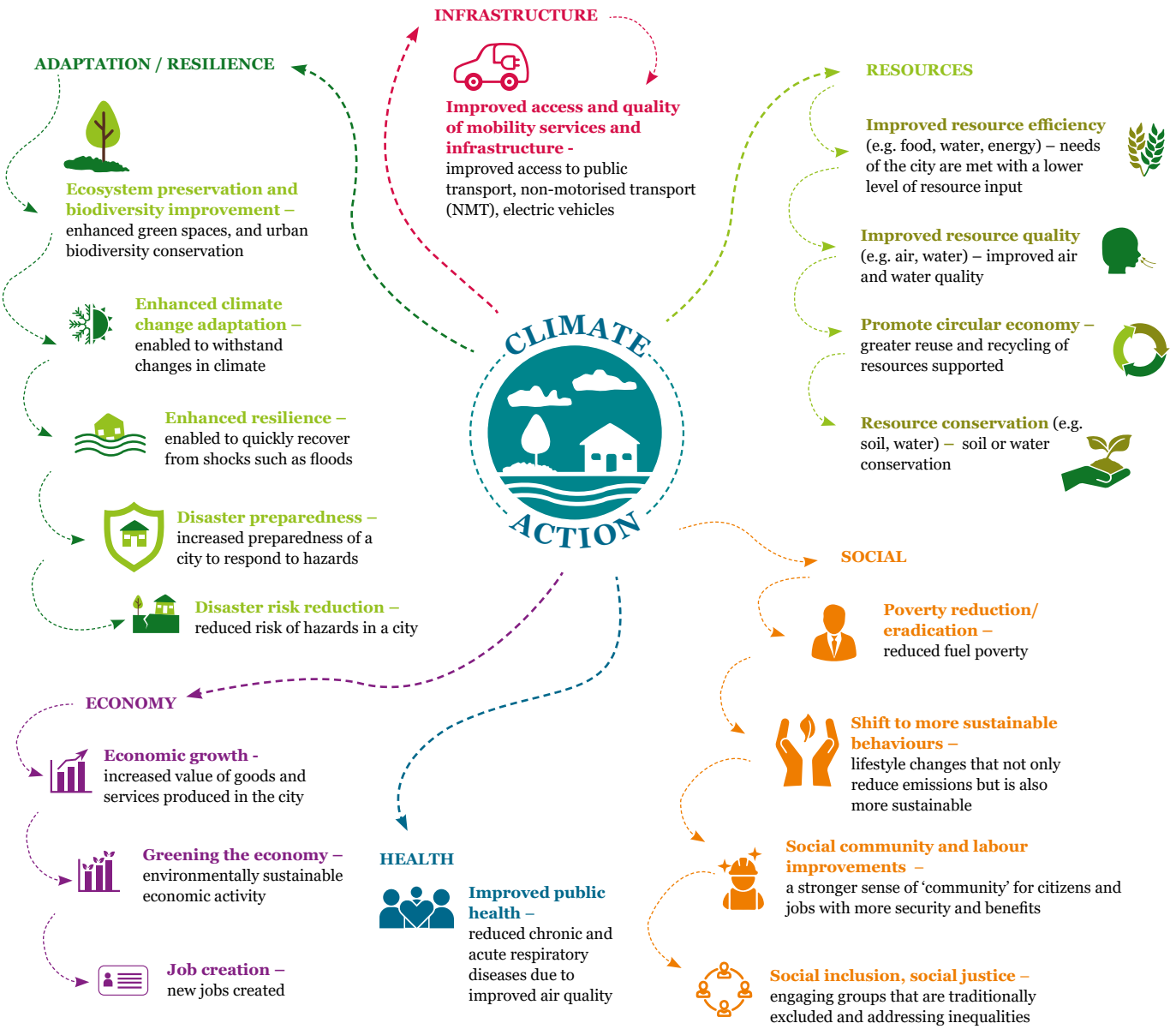


Impacts of climate change on cities

Major cities in India have witnessed the loss of life and property, disruptions to transport and power, incidences of epidemics due to floods during the monsoons, most notable amongst them being Mumbai in 2005, Surat in 2006, Kolkata in 2007, Chennai 2017, and cities in Kerala in 2018. The changing rainfall pattern due to climate change and various other associated factors of urbanization were key attributors to these incidents. These incidences also highlight the loss of life, public property, and inconveniences particularly due to traffic snarls.[28] Estimates state that 1.6 billion people living in over 970 cities globally, including Bengaluru, Chennai, Delhi, Jaipur, and Kolkata, will be regularly exposed to extreme high temperatures. And, over 800 million people living in 570 cities globally, including Chennai and Mumbai, will be vulnerable to sea-level rise and coastal flooding.[29] In 2019, many cities in India recorded all time high temperatures rising above 40°C, and exceeding 45° C in some of the worst affected states.[30]

According to IPCC, global sea levels are set to rise by at least 1m by 2100 if carbon emissions go unchecked, submerging hundreds of cities, including Mumbai and Kolkata.[31] By 2050, many coastal megacities and small island countries may face severe extreme weather events such as tropical cyclones, heavy rain, floods, intense waves, and other coastal hazards. Indian cities, including Mumbai, Kolkata, Chennai, and Surat could be among the severely impacted ones.[32]

Co-Benefits of Climate Actions in Cities[33]



3. CITIES AS STAKEHOLDERS IN CLIMATE AND SUSTAINABILITY AGENDAS

The role of cities at the forefront of climate change mitigation and adaptation was first discussed by a group of mayors in December 2009 during the Conference of Parties (COP) 15 in Copenhagen at the Climate Summit for Mayors organised jointly by the city of Copenhagen, C40, and ICLEI.[34] In recent years, the need to strengthen urban climate action has been discussed across major global agendas such as Sustainable Development Goals (SDGs) and the Paris Agreement. Non-party stakeholders (cities, businesses, investors, and civil society) came together to lend momentum to the Paris agreement in 2015 with commitments to act on climate change. At the UN Climate Conferences in Marrakesh (2016) and Bonn (2017), countries restated their understanding that success on climate change will require greater ambition from the non-state actors. The UN's 2015 SDGs included an explicit urban goal for the first time - Goal 11 (Sustainable Cities and Communities). Similarly, Goal 7 (Energy) and Goal 13 (Climate Action) are also relevant to cities. Over two-thirds of the submitted Nationally Determined Contributions (NDCs) show clear urban references and content, establishing the relationship between sustainable urbanization and climate action. The Sendai Framework for Disaster Risk Reduction (DRR) emphasizes the need for national and local DRR strategies. In 2018, IPCC published the 'Special Report on Global Warming of 1.5°C (SR1.5)' to explain the pathways to and impacts of limiting global warming to 1.5°C compared with 2°C on ecosystems, human health, and well-being. It showed that retaining global warming within 1.5°C would require global emissions to peak by 2020 and reduce to net-zero by 2050. The report identified cities and urban areas as one of the four critical global systems that can accelerate and upscale climate action and further recognized that this will require major transitions in how mitigation and adaptation/ resilience are undertaken.

These global efforts over the years, have gradually and successfully established that, while governments continue to play the pivotal role in strengthening climate action and subsequent mainstreaming of low carbon development pathways, non-state actors such as cities are gaining prominence as the catalysts to enhance and sustain this global momentum for change. The global policy push for mobilising cities towards progressive actions to achieve sustainable low-carbon growth is complemented by local actions in several cities across the globe. Mayors and local governments are increasingly rising to the challenge and providing the necessary impetus to climate change goals.

3.1 Climate Policy Scenario in India and its Relevance to Urban Development

In 2015, India submitted its NDC to the UNFCCC. It committed to reduce the emission intensity of the country's GDP by 33-35 percent from 2005 level by 2030, increase the share of non-fossil fuels-based electricity, and enhance the forest cover. The NDC revolves around India's policies and programmes to promote clean and renewable energy, develop less carbon-intensive and resilient urban centres, etc.[35] Several sectoral schemes and programmes, while contributing to the achievement of the national climate goals, also provide opportunities to enhance urban climate action in India. India is focussing on the transformation and rejuvenation of cities through various schemes and programmes, which aim to promote smart solutions that can make cities climate-resilient.

Energy

- The "Solar Cities" Mission was designed to support cities to prepare a road map to guide 'renewable energy cities' or 'solar cities'.[36]
- India Cooling Action Plan (ICAP) provides a 20-year perspective (2017-18 to 2037-38) and recommendations to address the cooling requirements across sectors and ways and means to provide access to sustainable cooling.[37]
- The Unnat Jyoti by Affordable LEDs for All (UJALA) scheme was launched to replace 77 crore incandescent lamps with LED bulbs. This scheme is being implemented in a phase-wise manner across the nation to facilitate the distribution of affordable LED bulbs and energy-efficient appliances.[38]

Transport

- National Urban Transport Policy encouraged interventions in urban transport such as Bus Rapid Transit System (BRTS), urban transit infrastructure,financing of metro rail projects, etc.[39]

- The National Electric Mobility Mission 2020 aims at promoting electric mobility in Indian cities.[40]

Waste

- Waste management is addressed through the Swachh Bharat Mission Urban (SBM-U), which aims to make urban India free from open defecation and achieve 100 percent scientific management of municipal solid waste.[41]

Housing

- Pradhan Mantri Awas Yojana (Urban) aims to ensure housing for all in urban areas to provide 'pucca' houses to eligible families by 2022.[42]
- The Global Housing Technology Challenge aims to identify and mainstream a basket of innovative construction technologies from across the globe for sustainable, eco-friendly and disaster-resilient housing construction in India.[43]
- The Buildings Energy Efficiency Programme is being implemented by Energy Efficiency Services Limited (EESL) to retrofit commercial buildings in India into energy-efficient complexes. Through these future-ready solutions, EESL is also creating a market for clean energy in India.[44]

Air Quality

- The National Clean Air Programme (NCAP) was launched to ensure stringent implementation of mitigation measures for prevention, control and abatement of air pollution, augment and strengthen air quality monitoring networks across the country, and increase public awareness and capacity building measures. [45]

Urban Green Cover

- The Nagar Van Scheme aims to develop 200 Urban Forests across the country in the next five years with a renewed focus on people's participation and holistic collaboration between stakeholders.[46]

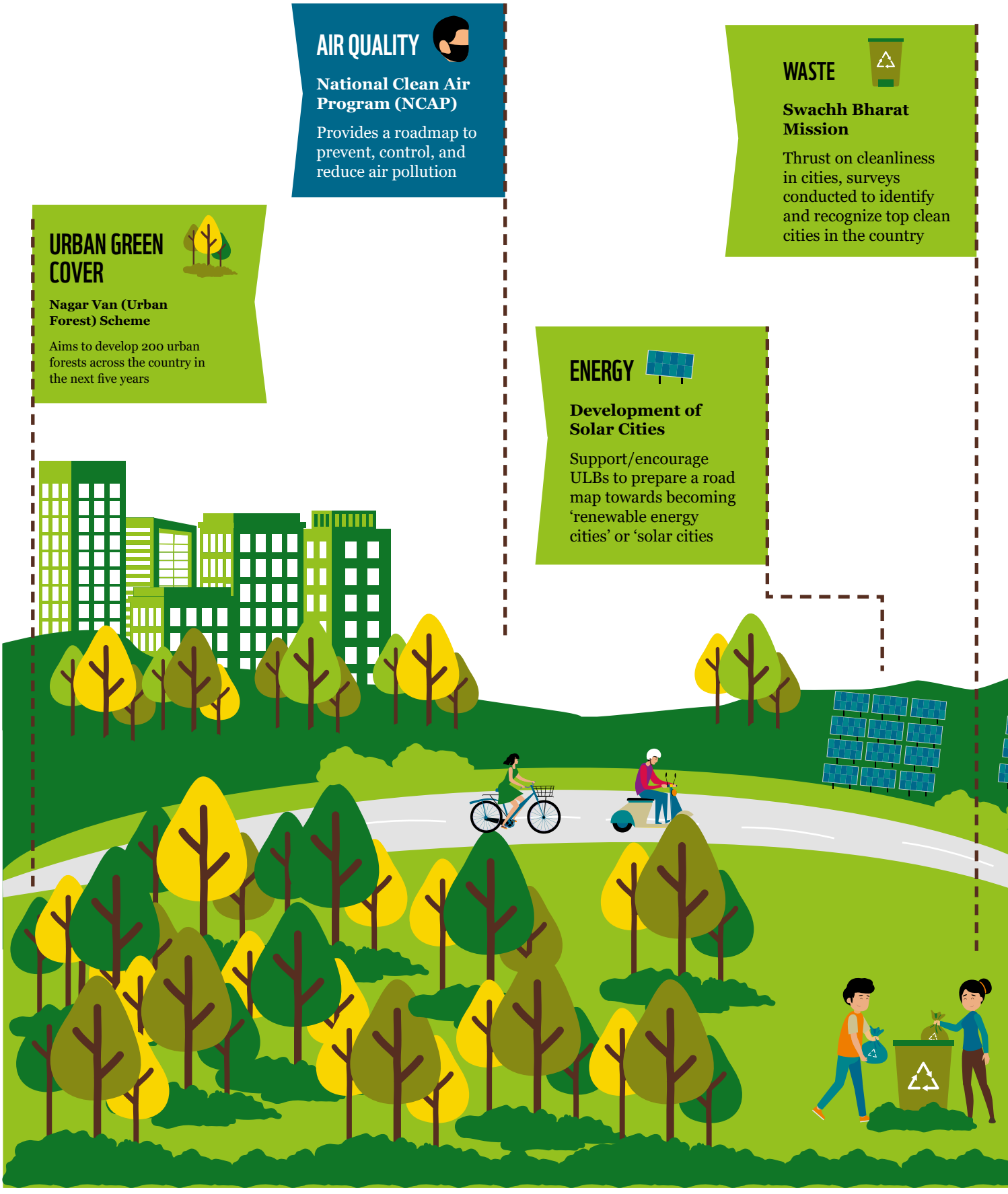
Urban Development

- The National Mission on Sustainable Habitat under the National Action Plan on Climate Change (NAPCC), 2008, aims to encourage sustainable urban planning in India with the help of policy, infrastructural, and research interventions in sectors such as buildings, waste management, transportation, and water resources.[47]
- The Jawaharlal Nehru National Urban Renewal Mission (JNNURM) focused on improved water supply and sanitation, solid waste management, road network, urban transport, and integrated development of slums, resulting in environmental and climate co-benefits.[48]
- The Smart Cities Mission (SCM) and Atal Mission for Rejuvenation and Urban Transformation (AMRUT) were launched to address the infrastructure gap in urban areas, besides enhancing the business and investment climate for the benefit of the poor. The Smart Cities Mission was further aligned with the national climate agenda through the ClimateSMART Cities Assessment Framework (CSCAF) initiated in 2019 for the 100 Smart Cities.[49]
- The National Urban Policy Framework 2018 recognizes environmental sustainability as a key element towards sustainable urbanization. It further states that making cities environmentally sustainable requires long-term integrated solutions for the urban planning system.[50]

3.2 ClimateSMART Cities Assessment Framework (CSCAF)

CSCAF is a first-of-its-kind cities assessment framework on climate-relevant parameters, such as energy and green buildings, urban planning, green cover & biodiversity, mobility and air quality, water resource management, and waste management. The objective is to provide a clear roadmap for urban India as a whole to combat climate change while planning and implementing actions, including investments. CSCAF serves as a tool for cities to assess their present situation and facilitate them to adopt, implement and disseminate the best practices. It further aims to set standards compared to the international efforts towards green, sustainable, and urban resilient habitats. Further, in July 2020, the Climate Centre for Cities (C-Cube) was launched with a vision to build climate action in cities. Instituted by the Ministry of Housing and Urban Affairs (MoHUA) under its Smart Cities Mission, and based at the National Institute of Urban Affairs (NIUA), C-Cube serves as a one-stop-shop for climate-informed actions to ensure a sustainable urban future for India. This is one of the most relevant initiatives by the national government to strengthen the integration of climate actions in urban development plans.[51]

Policy Support for Sustainable Urban Development and City Climate Actions



URBAN DEVELOPMENT

Smart Cities Mission/AMRUT

Prioritizing environmental sustainability through the adoption of smart solutions for improving quality of life in cities

National Urban Policy Framework

Includes environmental sustainability as one of the guiding principles

Mission on Sustainable Habitat

Building energy efficiency, urban planning, improved waste management, and sustainable transport

ClimateSMART Cities Assessment Framework

Guides climate actions in smart cities. Climate Centre for Cities (C-CUBE) launched in 2020 to support city-level climate action

4. CLIMATE MITIGATION

Mitigation is a human intervention to reduce the sources or enhance the sinks of greenhouse gases.[52] Climate mitigation strategies include enhancing renewable energy use, promoting low-carbon or zero-emission vehicles, adopting non-motorised transport (NMT), changing agricultural practices, limiting deforestation, etc. These offer feasible and cost-effective ways to reduce GHG emissions.[53] Cities can lead the way in climate mitigation by adopting and ensuring access to renewable energy and energy efficiency measures while recognizing the importance of sustainable, integrated urban planning to facilitate this transition. Cities can shift to sustainable urban planning and transportation, thereby facilitating low-carbon, energy-efficient development and physical greening of cities. Prioritizing pedestrians and bicycles, public transportation, supporting e-vehicles and car-sharing over private vehicles have multiple benefits, such as addressing air pollution and congestion, improving equity through accessibility, and enhancing biodiversity in cities.[54]

4.1. Case Studies

Cities being one of the significant contributors of GHG emissions, have undertaken multiple initiatives to reduce their emissions from the key sectors like transport, waste and energy. The following sections highlight some best practices related to climate mitigation from Indian & international cities.

TRANSPORT

Bus Rapid Transit System (BRTS), Ahmedabad

The Ahmedabad BRTS system has revolutionized the public transport system in the city by providing efficiency, affordability, safety, and security. It is branded and known as 'Janmarg'. Presently, the city has a 101 km long BRT corridor that operates 228 buses on 21 routes, making it one of India's largest operational BRT systems. This system has a ridership of approximately 0.16 million passengers per day. In the future, the Ahmedabad Janmarg Ltd. has also planned to include electric buses in the fleet, and provide last-mile connectivity through trunk & feeder operations. The BRT routes complement the Ahmedabad Municipal Transport Services (AMTS) bus routes, bringing the system within reach throughout the city. This has paved the way for transit-oriented development in the city, ensuring higher population density along the routes.[55]

MITIGATION

Enhanced use of renewable energy systems

- Aggressive renewable energy targets
- Solar power installations (rooftop PV, water heaters, street lights etc.), and wind-solar hybrid systems

Energy efficiency

- Energy efficient measures for lighting, buildings and housing
- Dedicated Energy Saving Cell to guide energy projects
- Sustainable housing practices

Transport

- Comprehensive mobility plans
- Improved public transport infrastructure & traffic management
- Mass Rapid Transport (Bus Rapid Transit and Metro)
- Non-motorized transport (pedestrian and cycle-friendly street designs)
- Fuel shift from diesel to CNG and/or electric

Waste management

- Efficient waste collection and management
- Composting and biomethanation.
- Waste recovery/recycling plants.
- Efficient Municipal Solid Waste Management (Waste-to-Energy plants)

Besides Ahmedabad, 10 cities in India have operational BRT systems with plans to expand the existing network, whereas 7 other BRT systems are under planning or construction.

Delhi Metro, Delhi

Delhi Metro started its operations in December 2002. The Delhi Metro Rail Corporation (DMRC) has a current network length of 389 km. With 285 stations spread across seven operational lines, the network is expected to increase to over 450 km after the construction of Phase IV.[56] In January 2020, Delhi Metro had an average ridership of 56.61 lakh per day. In terms of climate mitigation, DMRC became the first metro or railway project in the world in 2008 to be registered by the United Nations under the Clean Development Mechanism (CDM). The DMRC has registered CDM and Gold Standard projects, including regenerative braking, modal shift, and energy efficiency, which are expected to reduce approximately 5.7 lakhs tCO2 emission annually.[57]

Other metro projects in India include the one in Kolkata, which was the first in India to start operations in 1984. Currently, 13 Indian cities have functional metro systems, and ten other cities have them under construction. In another eleven cities, the metro systems are in the planning phase.

Streets Programme, Pune

The Pune Street Design Programme is one of India's most commendable mobility-related initiatives, which aims to transform 150 km of streets for walking and cycling and develop over 1,000 km of other major and minor streets with a focus on NMT. Pune was the first Indian city to prepare the Urban Street Design Guidelines 2016, which defines the street designing process, provides design templates for streets of varying widths, and sets standards for street elements. Pune has also created a dock-less Public Bicycle Sharing (PBS) system with 4,000 cycles run by four operators, which can be hired from any of the 800 cycle parking locations across the city through the bicycle-sharing apps.[58]

Promotion of Electric Vehicles

So far,18 Indian states have either notified or drafted their respective Electric Vehicle (EV) policies till 2021. These include Andhra Pradesh, Assam, Bihar, Chandigarh, Delhi, Gujarat, Haryana, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Meghalaya, Odisha, Punjab, Tamil Nadu, Telangana, Uttarakhand, and Uttar Pradesh. The policies aim to increase EV adoption in the states and make them preferred destinations for EV and component manufacturing. To achieve these objectives, states have provided a range of support in terms of consumer demand incentives, charging infrastructure incentives, and industry incentives.[59]

The Delhi Electric Vehicle Policy 2020, launched in August 2020, aims to achieve the overarching objective of improving Delhi's air quality and creating an entire supply-chain ecosystem for electric vehicles in the city. The policy intends to accelerate the pace of adoption of e-vehicles across segments, especially in the mass category of two-wheelers, public/shared transport vehicles, and goods carriers. The policy will be valid for the next three years and seeks to drive the rapid adoption of Battery Electric Vehicles (BEVs) to contribute to 25 percent of all new vehicle registrations by 2024. The Delhi government is targeting the induction of 35,000 electric two, three, four-wheelers and buses along with 1,000 electric vehicles for last-mile deliveries and 250 public charging and battery swapping stations. Road tax and registration fees for all battery electric vehicles have been waived off for the next three years. The collective target is estimated to amount to 500,000 EVs and 4.82 million tons in CO2 emissions savings. The fiscal incentives being offered would be in addition to the demand incentives available in the central government's FAME II scheme.[60]

Low Carbon Commute Transition Project, Kolkata

Kolkata plans to retain 88 percent modal share for public transport by further investing in and improving the existing public transport infrastructure. The city aims to introduce 5,000 electric buses and fully electrify the ferries plying across the Hooghly River by the year 2030. Kolkata must maintain a high modal share for public transport since it has only seven percent dedicated land area for streets and roads. With this initiative, Kolkata will become the first Indian megacity to complete the transition of its entire bus and ferry fleets to electric mode, further leading to the annual CO2 emissions reduction of 7,83,000 tonnes. As of 2019, 80 electric buses have been introduced, with plans to introduce another 100 buses by 2020. The total 180 electric buses will lead to an annual emissions reduction of 14,086 tonnes of CO2. The newly introduced electric buses are financially viable with their operational cost being one-third cheaper as compared to the existing diesel-powered buses.[61] Kolkata won the C40 Cities Bloomberg Philanthropies Award in 2019 for its ambitious Low Carbon Commute Transition Project.[62]

Public Bicycle Sharing System, Bijnor

The local administration of Bijnor created a unique PBS system based on the waste-to-wealth concept. Bicycles of the migrant labourers who moved to their hometowns during the Covid-19 pandemic were repaired and refurbished by the local administration and utilised to create PBS facilities. A fleet of 100 such bicycles with a unique brand identity was placed at 10 bicycle stands across the city. These bicycle stands were located at prime transit nodes like bus stands, railway stations, key government buildings, etc. Local youth and people with physical disabilities were provided employment to manage these stands. The PBS has provided a cost-effective low-carbon alternative for transit across the city. Also, the re-use of discarded bicycles aligns with one of the key principles of waste management, which prevents the usage of additional energy to recycle metal scrap. Some other co-benefits of this initiative include traffic decongestion, along with promoting sustainability and a healthy lifestyle.[63]

How Tokyo sustainably moves its 38 million inhabitants

The Tokyo Metropolitan Government set environmental policy targets for the years 2020 and 2030, which focus on reducing CO2 emissions through strategies like Zero Energy Buildings (ZEBs), Zero Emission Island (ZEI), and Zero-Emission Vehicles (ZEVs) to achieve the overarching target of 30 percent reduction in GHG emissions by 2030, compared to 2000 levels. Tokyo aims to increase the market share of Zero-Emission Vehicles to 50 percent of all new passenger car sales by the year 2030. To achieve this target, the city is working with relevant industries to promote the diffusion of products with low environmental loads, such as zero-emission bikes and ZEVs. Besides these, Tokyo has some of the fastest trains and one of the largest subway (metro rail) networks in the world. The city also encourages walking and biking for shorter trips over other modes of transport.[64]

WASTE

Verified Carbon Standard (VCS) Program, Indore

Indore has become the first Asian municipal body to register its sustainable city projects for carbon credits from Verified Carbon Standard, USA (VCS). Indore Smart City Development Limited (ISCDL) has registered three projects — a bio-methanation plant, a compost plant, and a 1.5 MW solar plant. This has led to the mitigation of 1.7 lakhtCO2e. The project has been registered for 30 years, and will get issuance of approximately 3,50,000 credits per annum, having an international carbon market value of avg. USD 200,000 - 400,000. ISCDL further plans to reinvest the revenue generated into other smart city projects with sustainability and climate co-benefits, focusing on renewable energy and energy-efficiency, such as a proposed solar power plant within the city.[65]

Decentralized Solid Waste Management System Towards a Bin-Free & Landfill-Less City, Panaji

Panaji launched a massive, comprehensive city revitalization campaign called "Bin Free in 2003" to improve the city's sanitary conditions and solid waste management (SWM) system. It aimed to reduce waste generation through behavioural change among the city's residents, leading to a 100 percent bin-free city through the successful door-to-door waste collection and waste segregation at source. It also emphasized mass awareness and extensive community engagement through the adoption of city-wide waste reduction measures. The campaign covered various aspects of SWM in the city and adopted an integrated approach to undertake the activities. The waste was segregated at the source into eight waste streams. Effective door-to-door waste collection services were provided throughout the city. Material recycling stations and decentralized composting units were established for the effective management of dry and wet waste. Besides these, the adoption of extended producer responsibility (EPR) initiatives through innovative strategies and fostering tie-ups with recycling units was also facilitated for efficient management of recyclables, hazardous waste, and e-waste generated in the city. Meanwhile, extensive campaigns and community engagement drives were launched across the city to increase mass awareness about the initiative and SWM issues.[66]

San Francisco's journey towards 'Zero Waste'

San Francisco has been a global leader in terms of waste management. The city is a signatory to the "Advancing Towards Zero Waste Declaration". Under this, the city aims to reduce municipal solid waste generation per capita by at least 15 percent by 2030 compared to 2015; reduce the amount of municipal solid waste disposed to landfill and incineration by at least 50 percent by 2030 compared to 2015; and increase the diversion rate away from landfill and incineration to at least 70 percent by 2030.[67] In 2003, San Francisco had initially set the "Zero Waste Goal" by 2020. It currently has a recycling rate of 81 percent, which is one of the highest in the United States. The city has recently adopted policies like the Refuse Separation Compliance Ordinance and the Single-Use Food Ware Plastics, Toxics, and Litter Reduction Ordinance to promote zero waste practices. Further, it has transformed a portion of its recycling facility sorting line with AI programmed industrial robots to sort the incoming waste.[68]

ENERGY

Smart Ghar – III, Rajkot

Residential buildings are responsible for 25 percent of India's energy consumption, with an expected rise to 38 percent by 2030 as cities continue to grow.[69] It is also unaffordable for many citizens to extensively use energy for cooling purposes during harsh Indian summers. Outdoor temperatures in Rajkot can reach up to 47°C in the summer, with indoor temperatures up to 38°C on a typical summer day. The lack of thermal comfort in exterior and interior areas results in the increased cooling requirements. To address these challenges, Rajkot initiated the Smart GHAR III initiative, under the Pradhan Mantri Awas Yojana (PMAY). This initiative served as a pilot to demonstrate affordable residences with thermal comfort and low energy consumption for lower-income groups. For this, the city collaborated with experts from the Indo–Swiss Building Energy Efficiency Project (BEEP) to analyse land characteristics where new units would be built, identify how temperatures could be lowered to increase indoor comfort, and facilitate low energy use. Final testing of finished Smart GHAR III dwelling units showed indoor temperature peaks decreased by 6°C, and the temperature remained below 30°C for an increased period, giving 1,176 families a better quality of life.[70] In order to align with Rajkot's commitment to reduce GHG emissions, the city has

also deployed rooftop solar at SMART GHAR III buildings to power elevators, streetlights, and water pumps. New Smart GHAR III housing complexes would further include well-planned green spaces and parking spots equipped with electric vehicle charging stations.[71]

Combined Waste Treatment and Solar PV initiative, Coimbatore

Coimbatore City Municipal Corporation (CCMC) has planned to install a 2 MW ground-mounted grid-connected solar PV power plant close to a proposed sewage treatment plant (STP) of 30.53 MLD capacity at Vellalore compost yard in Coimbatore district. The solar plant will be installed under the captive mode by CCMC, with excess generation exported to the grid and compensated with all other high tension (HT) consumption by the corporation. The power generated from the proposed solar power plant would be evacuated through a 22kV transmission line to the Pothnur Sub-Station of TANGEDCO.[72]

Under the solar city plan, Coimbatore proposed to provide grid incentives for solar power plants and install solar PVs and water heaters in all hospitals. The city planned to promote renewables, including replacement of kerosene lamps with solar lanterns for traders in the market; replacement of inverters and generators with solar PV systems in homes; installations of solar water heaters and solar PVs in residential complexes; investments in solar cookers and solar panels for schools and universities; biogas systems for restaurants; and solar water heaters and solar steam generators for industries.[73]

Renewable Energy Initiatives, Surat

In 2019, Surat Municipal Corporation (SMC) became the first Indian city to fulfill most of its energy requirements through renewable energy. Surat has a total renewable energy generation capacity of 120.2 MW, including 41 MW of solar energy, 73.7 MW of wind energy and 5.5 MW of biogas, which is higher than any other Indian city. The renewable energy generated from these sources is used to supplement 34 percent of SMC's energy requirement, which is equivalent to about 25 crore units of electricity per year, and provides power to more than 6,000 households. SMC also uses renewable energy to power the water treatment and distribution system, health care centres, and several municipal schools.[74]

Surat is also the first city in India to use solar energy for water distribution. The city has currently dedicated 4 MW capacity solar plants for water supply management, supplying about 53 lakh units per annum. The city is also planning to set up 100KW floating solar panels at Gopi Talav, besides installing solar panels on the rooftops of private entities and BRTS bus stops.[75]

Vancouver's zero emissions building plan

Vancouver is reducing GHG emissions radically for all new buildings over the next decade, since 2016. The city aspires to achieve net-zero emissions from all new buildings by the year 2030. It introduced the Zero Emissions Building (ZEB) Plan in 2016, which is based on highly energy-efficient houses using only renewable energy. Vancouver further plans to build only new ZEBs, alongside retrofitting older buildings to a higher energy-efficiency standard, switching to renewable energy to supply power to these buildings. The city is also aiming to update its building bye-laws in a step-by-step manner by the year 2030.[76]

5 CLIMATE ADAPTATION & RESILIENCE

Climate Adaptation can be defined as the process of adjustment to actual or expected climate and its effects. Adaptation strategies are needed to reduce the harmful impacts of climate change and allow the vulnerable population to thrive in the face of climate change. Because many GHGs have a lifetime of hundreds of years, severe climate impacts would be experienced even if we halted all GHG emissions today. Measures like cool roofs, restoration of wetlands, enhancing green cover and urban biodiversity, etc., are some of the effective adaptation strategies to reduce the impacts of extreme heatwaves and increased precipitation levels. Climate Resilience can be defined as the ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions.[77]

5.1. Case Studies

While the IPCC's Sixth Assessment Report (AR6) has highlighted that the climate impacts faced by cities may amplify in the near future, many cities have undertaken multiple actions at the local-level to adapt to the changing climate and build resilience against the future threats. The following are some of the best practices of climate adaptation/resilience from Indian and international cities.

Resilience Strategies – Surat, Pune, and Chennai

The 100 Resilient Cities (100RC) was a global project funded by the Rockefeller Foundation (100RC), dedicated to helping cities around the world become more resilient to physical, social, and economic challenges. The 100RC definition of resilience includes both shocks like heat waves, floods, etc., and stresses that weaken the fabric of a city in a regular manner.[78] In India, the 100RC worked with Surat, Pune, and Chennai to address the dual challenges of urbanization and climate change. The resilience strategy of Surat addressed challenges mainly related to the city's water security and flooding issues. In the case of Pune, the resilience strategy focused on urban mobility, urban environment including water body management and conservation of biodiversity, and urban economy, particularly the informal sector. Chennai addressed the challenges around food and nutrition, physical and mental well-being, job security, stormwater management, waste management, urban heat island mitigation, and disaster risk reduction.[79]

ADAPTATION AND CLIMATE RESILIENCE

Policy/Action Plans/ Institutional measures

- Implementing Heat Action Plans and Climate Change resilience
- Establishing early warning systems for floods and heat waves
- Establishing emergency/disaster management cells
- Creating awareness among citizens about actions to be taken during extreme events

Built Environment and Infrastructure

- Energy efficient measures for lighting, buildings and housing
- Dedicated Energy Saving Cell to guide energy projects
- Sustainable housing practices

Water management

- Recycling treated waste water.
- Rejuvenation of water bodies.

Urban Resilience, Gorakhpur

Gorakhpur has always received torrential downpours during the monsoon season. Stagnant floodwaters on the streets made Gorakhpur a hub for vector-borne diseases. In addition, rapid urbanisation increased the city's vulnerability. The blue-green spaces which served as natural flood defense for the city were being gradually overtaken. A city-based community group partnered with farmers in the city's periphery to implement climate-resilient agriculture methods to preserve open areas from urbanization and protect the city's natural flood defenses. They also organized household waste collection and recycling initiatives to prevent the natural drainage from clogging, thus helping these neighbourhoods become more resilient to flooding.[80]

How Cape Town Avoided 'Day Zero'

In 2018, Cape Town avoided "Day Zero"- the day when the city's taps were anticipated to run dry due to zero water availability, through the combined efforts of the municipality, behavioural change of its inhabitants, and good precipitation levels in June 2018. The municipality addressed the crisis by fixing leakages, reducing water flow, and restricting & pricing excess water usage. Cape Town also developed a new water strategy, which included desalination plants to obtain water from the sea, drew plans to recycle used water, and upgrade it to drinking water through treatment. Concurrently, citizens were made aware of behavioural changes to reduce water consumption. Finally, in June 2018, the city received a good amount of rainfall, and the dam levels increased to 43 percent of capacity.[81]

Lake Rejuvenation, Bengaluru

Jakkur Lake, located in the northern part of Bengaluru near Yelahanka, covers approximately 160 acres and receives stormwater through three inlet drains from Yelahanka, Agrahara, and Shivanahalli. Due to rapid urbanization, the storm water quantity decreased significantly over time and led the drains to dry up. The lake started receiving sewage from the nearby 12,500 households surrounding the lake.[82]

The Jakkur Lake Rejuvenation project in Bengaluru aimed to use natural and self-sustainable methods of treating domestic wastewater to rejuvenate the water body. It has improved biodiversity in the surrounding area and enhanced employment and livelihood opportunities for local fishermen. This lake restoration initiative is a classic example of the integration of conventional grey with green infrastructure. After desilting the lake, the original sewage treatment plant near the lake was upgraded using constructed wetlands for tertiary treatment of water. Islands were also created in the lake with tree plantations around its periphery to create bird habitats and maintain the natural flora and fauna. This initiative is a result of collaborative and multi-stakeholder engagement, which included sustainable landscaping such as permaculture, community gardens etc., developing a permanent space for the fishing community, and upgrading of existing sedimentation tank. This initiative has also facilitated the withdrawal of 100,000 litres of water from a nearby stepwell for agricultural purposes.[83]

Miyawaki Forest, Chennai

The Miyawaki method of forestry, also called the Potted Seedling Method, is an afforestation technique, which uses native or indigenous species of plants to create dense, multi-layered forests. Due to their dense nature, these forests are beneficial in reducing the urban heat island effect, improving soil health, supporting local biodiversity, and sequestering carbon.[84] It has been estimated that trees grow ten times faster than the traditional approach and provide thirty times denser green cover through this method.

Among the Indian cities planting Miyawaki forests, Chennai created its first dense urban forest in 2019 after 1,600 tonnes of debris was cleared from 2211.87 sqm. of land to plant more than 2,000 saplings of various native varieties. As the first Miyawaki forest in Chennai gained immense popularity, the city planted Miyawaki forests in about 20 locations in 2020 with plans to further raise 1,100 such plantations. While Miyawaki forests cannot replace original forests, they do provide realistic solutions for cities to mitigate vehicular pollution and address urban heat island effect.[85] Miyawaki forests are fast catching up as a way of increasing green cover in cities. Similar forests have been developed in Mumbai, Bengaluru, and other cities.

How Mexico city is building a nature park by cancelling its airport

In 2018, Mexico City canceled plans for a giant international airport and started building one of the world's largest ecoparks, the Parque Ecológico Lago de Texcoco. This park will be situated at the original lake system that fed the city's water supply. Over 16 kms wide and spread across 12,000 hectares of land, this park aims to rejuvenate drained lakes and restore swaths of Texcoco's wetlands in one of the city's last undeveloped areas while creating green infrastructure, recreational spaces, an urban forest for carbon sequestration to mitigate air pollution.[86] Presently the government has approved the environmental impact assessment, and the work related to the creation of public spaces shall be commenced soon.[87]

Yamuna Biodiversity Park, Delhi

The Yamuna Biodiversity Park is one of the biodiversity parks in Delhi developed through an innovative approach of ecological assemblages of species that form self-sustaining communities on barren/degraded landscapes. It is home to a diverse forest and grassland communities, biologically rich wetlands, and a large variety of fruit-yielding and medicinal

species. The Yamuna Biodiversity Park also comprises native flora and fauna that were once extinct, besides acting as a natural conservation site for a specific group of endangered plants. The park is presently spread across 457 acres of land on the western bank of the Yamuna river.[88]

The Yamuna Biodiversity Park and Delhi's other biodiversity parks, serve as the repositories for threatened species in the region. These biodiversity parks provide opportunities to mitigate air pollution, enrich the human microbiome critical for preventing health risks, recharge groundwater, mitigate flood risks, and contribute to Delhi's climate resilience. Besides these, they also provide recreational space to the public along with promoting environmental education.[89]

Local Biodiversity Strategy and Action Plan, Kochi

Kochi is the first city in India to have developed a scientifically informed and participatory Local Biodiversity Strategy and Action Plan (LBSAP). LBSAP articulates the method to implement the vision, strategic objectives, and actions necessary to conserve and protect the city's biodiversity. The Kochi LBSAP was supported by the Integrated Sub-National Actions for Biodiversity Supporting Implementation of National Biodiversity Strategy and Action Plan (INTERACT - Bio) project. The city aims to mainstream biodiversity conservation into urban planning. It has developed a vision to conserve its biodiversity, maintain the uninterrupted flow of ecosystem services, and ensure sustainable, safe, and climate-resilient development by managing its mosaic of ecosystems through a participatory planning approach. This LBSAP is based on the inputs received during multiple consultation meetings at the city and ward levels including, discussions with councillors, and subject matter experts.[90]

How Medellín's green corridors and rain gardens are preserving its ecosystems

Medellín, Colombia is cited as one of the success stories of biodiversity and green space conservation in the urban context. Between 2016 and 2019, the Medellín's Green Corridors Project created 36 green corridors between multiple natural areas to restore the green and blue belts of the city, which encouraged the movement of species. The city also planted 8,800 urban trees and developed rain gardens to support the local biodiversity and well-being of inhabitants. This has reduced the city's overall temperature by 2°C on average, facilitating disaster risk reduction, GHG emissions reduction, and creating green jobs.[91]

CARBON FOOTPRINT

What is Carbon Footprint? - Carbon footprint is the total Green House Gas (GHG) emissions, like Carbon dioxide (CO_2), Methane (CH_4), Nitrous oxide (N_2O) emitted directly or indirectly by an individual or an entity. It results from anthropogenic activities like burning fuels for heating, electricity generation, transportation, generation of waste etc.

It is measured in the unit of tCO_2. tCO_2eq stands for "Tonnes of CO_2 equivalent" (similarly $kgCO_2eq$ stands for "kilogram of CO_2 equivalent"). It is a measure for the amount of global warming a given type and amount of GHG may cause, using the functionally equivalent amount or concentration of CO_2 as the reference (in case of GHG other than CO_2). For instance, methane is a greenhouse gas that has a stronger effect on global warming than CO_2. It is found that methane has 21-28 times more greenhouse effect potential than CO_2. To be able to compare it with the effect of CO_2, it is converted into CO_2eq. Hence, 1t of methane has the same impact on climate change as 21-28 tCO_2.[92]

Direct and indirect GHG emissions as defined by the Green House Gas Protocol, which provides standards and guidance to measure and manage greenhouse gas (GHG) emission for businesses and governments:

- Direct GHG emissions are those, which originate from sources controlled or owned by the reporting individual/entity.
- Indirect GHG emissions result from the activities of the reporting individual/entity but originate at sources owned or controlled by another entity.

The Green House Gas Protocol further categorizes these direct and indirect emissions into three broad scopes:

- **Scope 1:** All direct GHG emissions.
- **Scope 2:** Indirect GHG emissions from consumption of purchased electricity or heat.
- **Scope 3:** Other indirect emissions, like extraction of metals and fuels, production of purchased materials, transport-related activities in vehicles not owned or controlled by the reporting entity, electricity-related activities (e.g. T&D losses) not covered in Scope 2, outsourced activities, waste disposal, etc.[93]

Source: https://u.osu.edu/extensioncd/tag/carbon-footprint/

Examples of Carbon Footprint Calculator

Carbon Footprint Calculator – 1

Hosted by: Climate Change Department, Government of Gujarat

This calculator contains the basic variables of energy consumption at the household level in terms of electricity, cooking fuel, transportation fuel.

To open the carbon footprint calculator, kindly click on the following link:

https://bit.ly/2PLk9O9

or Scan the code below:

Carbon Footprint Calculator – 2

Hosted by: WWF-India, New Delhi
Sponsored by: MoEFCC, Government of India

This calculator offers the provision to switch to Indian emission factors, along with a wide range of countries. It further calculates the carbon footprint based on household consumption of electricity and fuel along with detailed steps on various modes of transportation and other secondary sources of emissions.

To open the carbon footprint calculator, kindly click on the following link:

https://bit.ly/39QeHjY

or Scan the code below:

CALL FOR ACTION

Cities are the key contributors to climate change as anthropogenic activities in urban areas are major sources of greenhouse gas emissions. Cities are also negatively impacted by climate change due to rising sea levels, increasing frequency and severity of extreme weather events like floods, storms, heatwaves and increased incidence of water and vector-borne diseases.

COVID-19 has further exacerbated the situation and shifted the priority of the local governments away from climate actions due to the urgency of the post-recovery economic activities. Besides this, the pandemic has also exposed the gaps in the existing institutional framework towards tackling crises and rendering a large population of urban poor vulnerable to the impacts of future pandemics and climate change.

The priority for policymakers and local governments should be towards building back better through greener post-recovery measures that prioritise sustainable urbanisation. It is also important to build capacities of urban practitioners and line departments in cities to understand and address climate change. Successful climate action at the local level also calls for better coordination with the national and sub-national government to effectively utilize the government schemes and plans and ensure the availability of finance. Similarly, the government and civil society should also join hands towards spreading awareness about climate change among the citizens to sensitize them to take initiatives at the individual level. The decision-makers should be guided by sound scientific evidence. Therefore, academic and research organizations should be incentivized to undertake more research on various themes associated with climate change, especially in the urban context. Lastly, the businesses should aim towards a more sustainable pathway and explore ways to embrace low-carbon alternatives to support greener recovery.

This is also the opportunity to learn from the experiences in COVID-19 management and plan better towards reducing the vulnerability of cities from future shocks and stresses. This is the call for collective action by all the stakeholders in the urban context, i.e., the government, businesses, academia, civil society, and citizens, to join hands for a climate proof future for cities while ensuring the well-being of the society.

ENDNOTES

1 IPCC. (2021). Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. [MassonDelmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J. B. R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu and B. Zhou (eds.)]. Cambridge University Press. In Press.

2 IPCC. (2021). Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. [MassonDelmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J. B. R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu and B. Zhou (eds.)]. Cambridge University Press. In Press.

3 IPCC. (2018). Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. Retrieved from https://www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_AnnexI_Glossary.pdf.

4 IPCC. (2021). Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu and B. Zhou (eds.)]. Cambridge University Press. In Press.

5 Allen, M.R., O.P. Dube, W. Solecki, F. Aragón-Durand, W. Cramer, S. Humphreys, M. Kainuma, J. Kala, N. Mahowald, Y. Mulugetta, R. Perez, M. Wairiu, and K. Zickfeld. (2018). Framing and Context. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. In Press.

6 Lindsey, R., Dahlman, A. (2010). Climate Change: Global Temperature. Accessed on 21 July 2021. Retrieved from https://www.climate.gov/news-features/understanding-climate/climate-change-global-temperature.

7 NOAA National Centers for Environmental Information. (2021). State of the Climate: Global Climate Report for Annual 2020. Accessed on 25 August 2021. Retrieved from https://www.ncdc.noaa.gov/sotc/global/202013.

8 Uejio, C.K., Tamerius, J.D., Wertz, K. & Konchar, K.M. (2015). Primer on climate science. In G Luber & J Lemery (Eds.), Global Climate Change and Human Health (pp. 12-18), San Francisco, CA.

9 Watts, N., Amann, M., Arnell, N., Ayeb-Karlsson, S., Belesova, K., Boykoff, M., ... Capstick, S. (2019). The 2019 Report of The Lancet Countdown on health and climate change: ensuring that the health of a child born today is not defined by a changing climate. The Lancet. doi:10.1016/s0140-6736(19)32596-6

10 Hoegh-Guldberg, O., D. Jacob, M. Taylor, M. Bindi, S. Brown, I. Camilloni, A. Diedhiou, R. Djalante, K.L. Ebi, F. Engelbrecht, J. Guiot, Y. Hijioka, S. Mehrotra, A. Payne, S.I. Seneviratne, A. Thomas, R. Warren, and G. Zhou, 2018: Impacts of 1.5°C Global Warming on Natural and Human Systems. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. In Press.

11 National Health Portal of India. (2019). Health and Climate Change. Accessed on 22 July 2021. Retrieved from https://www.nhp.gov.in/health-and-climate-change_pg.

12 IIED. (2020). Cities: where public health and climate experts must meet. Accessed on 22 July 2021. Retrieved from https://www.iied.org/cities-where-public-health-climate-experts-must-meet.

13 Harvard Chan C-CHANGE. (n.d.). Coronavirus, Climate Change, and the Environment - A Conversation on COVID-19 with Dr. Aaron Bernstein, Director of Harvard Chan C-CHANGE. Accessed on 22 July 2021. Retrieved from https://www.hsph.harvard.edu/c-change/subtopics/coronavirus-and-climate-change/.

14 Climate Transparency. (2020). Climate Transparency Report 2020 - India. Retrieved from https://www.climate-transparency.org/wp-content/uploads/2020/11/India-CT-2020-WEB.pdf.

15 MoEFCC. (2018). India: Second Biennial Update Report to the United Nations Framework Convention on Climate Change. Ministry of Environment, Forest and Climate Change, Government of India.

16 Eckstein, D., Künzel, V., Schäfer, L., (2021). Global Climate Risk Index 2021. GermanWatch. Retrieved from https://germanwatch.org/sites/default/files/Global%20Climate%20Risk%20Index%202021_2.pdf.

17 Mohanty, A. (2020). Preparing India for Extreme Climate Events: Mapping Hotspots and Response Mechanisms. New Delhi: Council on Energy, Environment and Water.

18 Eckstein, D., Künzel, V., Schäfer, L., (2021). Global Climate Risk Index 2021. GermanWatch. Retrieved from https://germanwatch.org/sites/default/files/Global%20Climate%20Risk%20Index%202021_2.pdf.

19 Eckstein, D., Künzel, V., Schäfer, L., (2021). Global Climate Risk Index 2021. GermanWatch. Retrieved from https://germanwatch.org/sites/default/files/Global%20Climate%20Risk%20Index%202021_2.pdf.

20 India Meteorological Department. (2021). Statement on Climate of India during 2020. Retrieved from https://mausam.imd.gov.in/backend/assets/press_release_pdf/Statement_of_Climate_of_India-2020.pdf

21 Climate Transparency. (2020). Climate Transparency Report 2020 - India. Retrieved from https://www.climate-transparency.org/wp-content/uploads/2020/11/India-CT-2020-WEB.pdf.

22 MoEFCC. (2021). India: Third Biennial Update Report to the United Nations Framework Convention on Climate Change. Ministry of Environment, Forest and Climate Change, Government of India.

23 World Bank. (2013). Turn Down the Heat: Climate Extremes, Regional Impacts, and the Case for Resilience.

24 Harman, O. (2019). Climate change: won or lost in cities or by cities? Accessed on 22 July 2021. Retrieved from https://www.weforum.org/agenda/2019/09/climate-change-won-or-lost-in-cities-or-by-cities/.

25 Khosla, R., Bhardwaj, A. (2017). Can Indian cities lead on climate action as they go about their development goals?. Scroll. in. Accessed on 22 July 2021. Retrieved from https://scroll.in/article/841788/can-indian-cities-lead-on-climate-action-as-they-go-about-their-development-goals.

26 TERI. (2015); Draft Report on the "Study on quantification of the Greenhouse Gas mitigation potential of the various development initiatives undertaken by Government of India"

27 Ministry of Environment, Forest & Climate Change, Government of India. (2019). National Clean Air Programme (NCAP). Retrieved from https://moef.gov.in/wp-content/uploads/2019/05/NCAP_Report.pdf

28 Ministry of Housing And Urban Affairs. (2019). ClimateSMART Cities Assessment Framework. Retrieved from https://www.niua.org/csc/assets/pdf/key-documents/Climate-Smart-Cities-booklet.pdf.

29 UCCRN,2018. The Future We Don't Want: How Climate Change Could Impact the World's Greatest Cities. Technical Report. Retrieved from https://c40-production-images.s3.amazonaws.com/other_uploads/images/1789_Future_We_Don't_Want_Report_1.4_hi-res_120618.original.pdf.

30 National Disaster Management Authority. (2019). National Guidelines for Preparation of Action - Prevention and Management of Heat Wave. Retrieved from https://nidm.gov.in/pdf/guidelines/new/guidelines_heatwaveguidelines.pdf.

31 UCCRN,2018. The Future We Don't Want: How Climate Change Could Impact the World's Greatest Cities. Technical Report. Retrieved from https://c40-production-images.s3.amazonaws.com/other_uploads/images/1789_Future_We_Don't_Want_Report_1.4_hi-res_120618.original.pdf.

32 Oppenheimer, M., B.C. Glavovic, J. Hinkel, R. van de Wal, A.K. Magnan, A. Abd-Elgawad, R. Cai, M. Cifuentes-Jara, R.M. DeConto, T. Ghosh, J. Hay, F. Isla, B. Marzeion, B. Meyssignac, and Z. Sebesvari. (2019). Sea Level Rise and Implications for Low-Lying Islands, Coasts and Communities. In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)]

33 CDP. (2020). The Co-Benefits of Climate Action - Accelerating City-level Ambition

34 The World Bank. (2010). Cities & Climate Change: An Urban Agenda. Urban Development Series Knowledge Paper

35 Ministry of Housing And Urban Affairs. (2019). ClimateSMART Cities Assessment Framework. Retrieved from https://www.niua.org/csc/assets/pdf/key-documents/Climate-Smart-Cities-booklet.pdf.

36 WWF-India. (2020). Background Paper on Cities and Climate Change: the Indian context.

37 WWF-India. (2020). Background Paper on Cities and Climate Change: the Indian context.

38 MoEFCC. (2021). India: Third Biennial Update Report to the United Nations Framework Convention on Climate Change. Ministry of Environment, Forest and Climate Change, Government of India.

39 WWF-India. (2020). Background Paper on Cities and Climate Change: the Indian context.

40 WWF-India. (2020). Background Paper on Cities and Climate Change: the Indian context.

41 Ministry of Housing and Urban Affairs. (n.d.). Swachh Bharat Mission. Accessed on 22 July 2021. Retrieved from http://mohua.gov.in/cms/swachh-bharat-mission.php.

42 Ministry of Housing and Urban Affairs. (n.d.). Pradhan Mantri Awas Yojana (Urban) - FAQ. Accessed on 22 July 2021. Retrieved from https://pmay-urban.gov.in/faq.

43 Press Information Bureau. (2020). 5th Anniversary of Urban Missions. Ministry of Housing & Urban Affairs. Accessed on 22 July 2021. Retrieved from https://pib.gov.in/PressReleseDetailm.aspx?PRID=1634268

44 MoEFCC. (2021). India: Third Biennial Update Report to the United Nations Framework Convention on Climate Change. Ministry of Environment, Forest and Climate Change, Government of India.

45 WWF-India. (2020). Background Paper on Cities and Climate Change: the Indian context.

46 Press Information Bureau. (2020). Urban Forest scheme to develop 200 'Nagar Van' across the country in next five years. Ministry of Environment, Forest and Climate Change. Accessed on 22 July 2021. Retrieved from https://pib.gov.in/PressReleasePage.aspx?PRID=1629563.

47 WWF-India. (2020). Background Paper on Cities and Climate Change: the Indian context.

48 JNNURM. (2005). PM launches Jawaharlal Nehru National Urban Renewal Mission. Accessed on 22 July 2021. Retrieved from https://web.archive.org/web/20120517045523/http://jnnurm.nic.in/wp-content/uploads/2011/01/Prime-Ministers-Office.htm

49 WWF-India. (2020). Background Paper on Cities and Climate Change: the Indian context.

50 Ministry of Housing & Urban Affairs. (2018). National Urban Policy Framework 2018. Retrieved from https://smartnet.niua.org/sites/default/files/resources/nupf_final.pdf.

51 NIUA. (2021). Climate Centre For Cities (C-Cube). Accessed on 9 September 2021. Retrieved from https://www.niua.org/c-cube/content/climate-centre-cities-c-cube.

52 IPCC. (2014). Summary for Policymakers. In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Retrieved from https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_summary-for-policymakers.pdf.

53 Public Health Institute/Center for Climate Change and Health. (2016). Climate Change 101: climate science basics. Retrieved from https://climatehealthconnect.org/

54 WWF. (n.d.). Cities in the Climate Crisis: Energy & urban planning to support 1.5°C alignment. WWF Cities Policy Paper Series

55 Ahmedabad Janmarg Ltd. (n.d.). About Janmarg. Retrieved from http://www.ahmedabadbrts.org/.

56 Delhi Metro Rail Corporation. (n.d.). About Us. Retrieved from http://www.delhimetrorail.com/about_us.aspx#Introduction.

57 Delhi Metro Rail Corporation Ltd. (n.d.). Green Initiative. Accessed on 12 October 2021. Retrieved from http://www.delhimetrorail.com/greeninitiative.aspx.

58 Pune Municipal Corporation. (2021). Pune's Sustainable Transport Journey. Prepared for Pune Municipal Corporation by ITDP

59 WRI. (2021). A review of State Government Policies for Electric Mobility

60 Government of NCT of Delhi, India. (n.d.). Making Delhi the EV capital of India. Retrieved from https://ev.delhi.gov.in/.

61 C40 Cities Climate Leadership Group. (2019). Cities100: Kolkata is electrifying buses and ferries. Case Studies and Best Practice Example. Accessed on 12 October 2021. Retrieved from https://www.c40knowledgehub.org/s/article/Cities100-Kolkata-is-electrifying-buses-and-ferries

62 C40 Cities Climate Leadership Group. (2019). World's 26 Best Climate Projects Compete For The 2019 C40 Cities Bloomberg Philanthropies Awards. Accessed on 12 October 2021. Retrieved from https://www.c40.org/press_releases/2019-c40-awards-finalists

63 Gadkari, N. (2021, March 16). 'Bikes of Bijnor', a waste to wealth public bike sharing programme [Video file]. YouTube. Retrieved from https://www.youtube.com/watch?v=vaQTC5nLxdA&feature=youtu.be.

64 WWF. (2019). Tokyo – Getting around in the world's largest metropolis. Urban Solutions 2019. Retrieved from https://wwfint.awsassets.panda.org/downloads/wwf_uscases_2019_tokyo.pdf.

65 CISION. (2019). Indore's Municipal Corporation Becomes the First Asian Municipal Body to get its Sustainable City Projects Registered for Carbon Credits from VCS (Verified Carbon Standard, USA) Program

66 Ministry of Housing And Urban Affairs. (2019). ClimateSMART Cities Assessment Framework. Retrieved from https://www.niua.org/csc/assets/pdf/key-documents/Climate-Smart-Cities-booklet.pdf.

67 C40 Cities. (n.d.). Advancing Towards Zero Waste Declaration. Accessed on 22 July 2021. Retrieved from https://www.c40.org/other/zero-waste-declaration.

68 C40 Cities. (n.d.). How Cities Are Building The Future We Want: City progress towards meeting Advancing Towards Zero Waste Declaration commitments. Retrieved from https://c40-production-images.s3.amazonaws.com/other_uploads/images/2347_DECLARATION_PROGRESS_WASTE_160919.original.pdf?1568618444.

69 INDO-SWISS Building Energy Efficiency Project (BEEP). (2019). Technical assistance for thermal comfort and energy efficient design

70 CapaCITIES. (n.d.). Quick Win Project – Rajkot Solar PV in Social Housing. Retrieved from http://capacitiesindia.org/wp-content/uploads/2018/08/Quickwin-Projects-Rajkot_Solar-PV-Social-Housing.pdf.

71 WWF. (2021). Rajkot – Efficient cooling is key. Urban Solutions 2021. Retrieved from https://wwfint.awsassets.panda.org/downloads/wwf_us_case_2021_rajkot_v2.pdf.

72 CapaCITIES. (n.d.). Climate Resilient Cities Action Plan - Coimbatore. Retrieved from http://capacitiesindia.org/wp-content/uploads/2018/04/Coimbatore_CRCAP.pdf.

73 WWF. (2014). Coimbatore solar city. Urban Solutions 2014. Accessed on 22 July 2021. Retrieved from https://wwf.panda.org/?229190/Coimbatore-solar-city.

74 Mathur, B. (2019, May). The Diamond City of India – Surat Gets The Tag Of Generating Maximum Amount Of Renewable Power In The Country. NDTV. Retrieved from https://swachhindia.ndtv.com/solar-energy-wind-biogas-surat-becomes-the-city-to-generate-maximum-amount-of-renewable-power-in-the-country-34060/.

75 As submitted during OPCC 2021-22 data reporting

76 WWF. (2019). Vancouver - The Zero Emissions Building Plan. Urban Solutions 2019. Retrieved from https://d2ouvy59p0dg6k.cloudfront.net/downloads/wwf_uscases_2019_vancouver.pdf.

77 IPCC. (2012). Glossary of terms. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. A Special Report of Working Groups I and II of the IPCC. Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 555-564

78 Climate Initiatives Platform. (n.d.). 100 Resilient Cities. Retrieved from https://climateinitiativesplatform.org/index.php/100_Resilient_Cities.

79 Resilient Cities Network. (n.d.). Urban Resilience. Accessed on 22 July 2021. Retrieved from https://resilientcitiesnetwork.org/urban-resilience/.

80 The City Fix. (2019). In Gorakhpur, India, Citizens Use Nature to Rein in Floods. Accessed on 22 July 2021. Retrieved from https://thecityfix.com/blog/gorakhpur-india-citizens-use-nature-rein-floods-jillian-du/.

81 WWF. (2019). Cape Town: Avoiding “Day Zero”. Urban Solutions 2019. Retrieved from https://wwfint.awsassets.panda.org/downloads/wwf_uscases_2019_cape_town.pdf.

82 Ministry of Housing and Urban Affairs. (2020). Best Practices Compendium - ClimateSmart CITIES

83 Centre for Science and Environment. (n.d.). Jakkur Lake - Urban Lake Management. Accessed on 22 July 2021. Retrieved from https://www.cseindia.org/jakkur-lake-urban-lake-management-6402%0D

84 Vashisth, N. (2019). Role of Miyawaki forests in mitigating urban heat island effects. Mongabay. Accessed on 22 July 2021. Retrieved from https://india.mongabay.com/2019/09/role-of-miyawaki-forests-in-mitigating-urban-heat-island-effects/

85 Prabhakar, B. (2021). Creating mini Miyawaki forests in the city: A step-by-step guide. Accessed on 22 July 2021. Retrieved from https://chennai.citizenmatters.in/chennai-guide-to-creating-miyawaki-forests-24787

86 WWF. (2021). Mexico City – Metropolis adapts realistic goal. Urban Solutions 2021. Retrieved from https://wwfint.awsassets.panda.org/downloads/wwf_us_case_2021_mexico_city_v2.pdf.

87 El Economista. (2021). Lake Texcoco Ecological Project. Accessed on 22 July 2021. Retrieved from https://www.eleconomista.com.mx/empresas/Semarnat-avala-MIA-de-parque-recreativo-en-terrenos-del-NAIM-20210709-0014.html.

88 Delhi Biodiversity Foundation. (2016). Biodiversity Parks - Yamuna Biodiversity Park. Accessed on 22 July 2021. Retrieved from http://www.delhibiodiversityparks.org/yamuna-biodiversity-park.html.

89 University of Delhi. (n.d.). Biodiversity Parks: Examples of Innovation and Best Practices for Biodiversity Conservation. Centre for Environmental Management of Degraded Ecosystems (CEMDE). Retrieved from http://du.ac.in/du/uploads/06032018_Biodiversity_Parks.pdf.

90 ICLEI South Asia. (2020). Local Biodiversity Strategy and Action Plan for Kochi Municipal Corporation. Prepared under the BMU supported INTERACT-Bio project

91 WWF International. (2021). Urban Nature Based Solutions - Cities leading the way - 2021. Retrived from https://wwfint.awsassets.panda.org/downloads/exe_wwf_a4_template_sbn_final2.pdf

92 Greenhouse Gas Protocol. (n.d.). Global Warming Potential Values. Retrieved from https://www.ghgprotocol.org/sites/default/files/ghgp/Global-Warming-Potential-Values%20%28Feb%2016%202016%29_1.pdf.

93 Government of Gujarat - Climate Change Department. (n.d.). Carbon Footprint Calculator. Accessed on 22 July 2021. Retrieved from https://ccd.gujarat.gov.in/carbon-footprint-calculator-clim.htm.


© Shutterstock / Olga Kashubin / WWF

WWF

Working to sustain the natural world for the benefit of people and wildlife.

together possible™

panda.org